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DAELIM POLYBUTENE
INTRODUCTION

As a leading company in Korean petrochemical industry, Daelim has initially embarked on the research of polybutene in 1986, and hence created greater value in C4 stream. After carrying out quality improvement and process development, Daelim has been supplying Conventional Polybutene (C-PB) since 1994. In addition to accomplishment of C-PB, it successfully launched and dispensed High Reactive Polybutene (HRPB), and then it has been also butting to all different areas in the world.

Daelim Polybutene is the environmentally friendly product in human life. Daelim Polybutene is being manufactured in the world class Yeosu Complex equipped with state-of-the-art facilities.

BRIEF HISTORY OF DAELIM POLYBUTENE
As a leading company in Korean petrochemical industry, Daelim has initially embarked on the research of polybutene in 1986, and hence created greater value in C4 stream. After carrying out quality improvement and process development, Daelim has been supplying Conventional Polybutene (C-PB) since 1994. In addition to accomplishment of C-PB, it successfully launched and dispensed High Reactive Polybutene (HRPB), and then it has been also butting to all different areas in the world.

CHARACTERISTICS
Daelim Polybutene is chemically stable and resistant to oxidation by both light and moderate heat. All grades are water-white, hydrophobic and non-toxic. It has narrow molecular weight distribution and negligible sulfur content.

INTRODUCTION OF DAELIM POLYBUTENE
Daelim Polybutene implements the role of the world No.1 in quality and customer service. Daelim Polybutene is the environmentally friendly product in human life. Daelim Polybutene has being manufactured in the world class Yeosu Complex equipped with state-of-the-art facilities.

As a result of this success in state-of-the-art technology, Daelim has become only a provider in the world that is able to manufacture both C-PB and HRPB in a single plant. Currently, Daelim develops and offers diverse grades of polybutene, hence it thrives in enlarging value to its customers as the second largest polybutene supplier in the global market with 140,000 MTA Capacity. Daelim’s high technology and integrity that the company pursues above all others offer the benefits to its customers.
Daelim Polybutene was granted the KT mark for new localized technology and the Ministry of Science & Technology and the Korea Industrial Technology Promotion Association in November 1994. The company also received the RS2 Chang Young-sil Award for technological excellence in 1995.

### GENERAL GRADE & TYPICAL VALUE

<table>
<thead>
<tr>
<th>Classification</th>
<th>Physical Properties</th>
<th>Chemical Properties</th>
<th>Electrical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molecular Weight</td>
<td>Viscosity</td>
<td>Flash Point</td>
</tr>
<tr>
<td></td>
<td>(GPC)</td>
<td>(D445)</td>
<td>(COC)</td>
</tr>
<tr>
<td>ASTM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PB300</td>
<td>300</td>
<td>27</td>
<td>138</td>
</tr>
<tr>
<td>PB93</td>
<td>400</td>
<td>10</td>
<td>160</td>
</tr>
<tr>
<td>PB55</td>
<td>500</td>
<td>33</td>
<td>200</td>
</tr>
<tr>
<td>PB93</td>
<td>600</td>
<td>80</td>
<td>1,700</td>
</tr>
<tr>
<td>PB90</td>
<td>800</td>
<td>108</td>
<td>2,400</td>
</tr>
<tr>
<td>PB1300</td>
<td>1,300</td>
<td>645</td>
<td>22,000</td>
</tr>
<tr>
<td>PB1400</td>
<td>1,400</td>
<td>810</td>
<td>27,000</td>
</tr>
<tr>
<td>PB2100</td>
<td>2,000</td>
<td>2,000</td>
<td>72,000</td>
</tr>
<tr>
<td>PB2200</td>
<td>2,200</td>
<td>3,200</td>
<td>120,000</td>
</tr>
<tr>
<td>PB2400</td>
<td>2,400</td>
<td>4,700</td>
<td>208,000</td>
</tr>
<tr>
<td>HRPB930</td>
<td>750</td>
<td>90</td>
<td>2,300</td>
</tr>
<tr>
<td>HRPB1300</td>
<td>1,200</td>
<td>190</td>
<td>4,300</td>
</tr>
<tr>
<td>HRPB1500</td>
<td>1,300</td>
<td>470</td>
<td>14,000</td>
</tr>
<tr>
<td>HRPB2000</td>
<td>2,300</td>
<td>1,500</td>
<td>52,000</td>
</tr>
</tbody>
</table>

- The above data is a typical value.

### PROPERTIES

#### Color

Daelim Polybutene is generally water-white, reaching less than 50 on APHA color scale, typically less than 10. The product remains verystable after being prolonged exposure to UV light. Daelim Polybutene is more stable than conventional mineral oil with same APHA color.

#### Tackiness

Tackiness increases as the molecular weight and viscosity increase.

#### Purity & Toxicity

Daelim Poly-butene has neither additive nor chlorine & sulfur content hence it is famous for high purity and non-toxic characteristic.

#### Stability

Daelim Polybutene is chemically therefore it contains excellent stability to heat and UV radiation.

#### Viscosity

Viscosity of Daelim Polybutene that is measured by Cannon-Fensky capillary viscometer and Kinematic viscosity is between 10 and 5,000cSt at 100℃. As the average molecular weight rises up, kinematic viscosity increases.

#### 01 Kinematic Viscosity - Temperature Characteristics

The viscosity depends on the temperature. Based on ASTM D341, viscosity changes can be generally predicted as follows.

\[ \log(\nu_{20}) = A - B \log(T) \]

| Temperature (℃) | PB95 | 70 | 200 | 20 | 10 |
|-----------------|------|-----|-----|----|
| 100             | 1.37 | 1.45 | 1.50 | 1.55 | 1.60 |
| 110             | 1.33 | 1.42 | 1.47 | 1.52 | 1.56 |
| 120             | 1.29 | 1.38 | 1.43 | 1.48 | 1.53 |
| 130             | 1.25 | 1.34 | 1.39 | 1.44 | 1.49 |
| 140             | 1.21 | 1.30 | 1.35 | 1.40 | 1.45 |
| 150             | 1.17 | 1.26 | 1.31 | 1.36 | 1.41 |

#### 02 Blending of Daelim Polybutene

When blending two grades of Daelim Polybutene of different viscosity to obtain a product of desired viscosity, the following formula can be used.

\[ \log(\nu_{T}) = X \log(\nu_{1}) + (1 - X) \log(\nu_{2}) \]

<table>
<thead>
<tr>
<th>Lighter Polymer Weight Ratio(%)</th>
<th>100</th>
<th>90</th>
<th>80</th>
<th>70</th>
<th>60</th>
<th>50</th>
<th>40</th>
<th>30</th>
<th>20</th>
<th>10</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighter Polymer Viscosity(cSt)</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

#### DAEIL POLYBUTENE BLENDING CHART (at 100℃)

See diagram for blending chart.
**PHYSICAL PROPERTIES**

**Molecular Weight**
The number average molecular weight (Mn) in Daelim Polybutene ranges from 300 and 2,500. The Mn can be determined experimentally with gel permeation chromatography.

**Density**
The density of Daelim Polybutene varies with temperature changes as follows.

**ELECTRICAL PROPERTIES**

Daelim Polybutene does not contain inorganic materials and conductors; its own insulating property is excellent.

**CHEMICAL PROPERTIES**

**Solubility & Compatibility**
Daelim Polybutene is a non-polar hydrocarbon polymer hence it has high solubility in aliphatic, aromatic and chlorinated solvents. It is compatible with a wide variety of organic materials, for instance, synthetic hydrocarbon polymers including wax, rosin, asphalt and gum.

**KINEMATIC VISCOSITY VS MOLECULAR WEIGHT (by VPO)**

**CHEMICAL PROPERTIES**

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**KINEMATIC VISCOSITY VS MOLECULAR WEIGHT (by VPO)**
FUEL & LUBRICANT ADDITIVES

Modified polybutene is used for the fuel & lubricant additives.

Fuel Dispersants
Detergents serve to reduce deposits on the engine valve and emit low exhaust smoke, and also prolong the lifetime of engine. Daelim Polybutene derivative is a performance material added to fuel detergent to provide excellent cleanliness.

Lubricant Dispersants
Dispersants serve to reduce and prevent deposits in engine. Those in commercial use are prepared from polybutene and they minimize engine deposits at low temperature.

ADHESIVES

Daelim Polybutene is used for wide application in the formulation of various types of adhesives such as Pressure Sensitive Adhesive(PSA) and Hot Melt Adhesive(HMA).

Pressure Sensitive Adhesive(PSA)
Base polymer : natural rubber, SIS, SBR, PB etc.
Tackifier : hydrocarbon resin, resin, polybutene etc.
Others : filler, antioxidant, solvent etc.
Daelim Polybutene improves the tack and peel strength of elastomers. Major application of PSA is general & insulation tapes.

Hot Melt Adhesive(HMA)
Base polymer : EVA, SBS, SIS, APP, PE etc.
Tackifier : hydrocarbon resin, polybutene etc.
Others : paraffin wax, filler, antioxidant etc.
Daelim Polybutene increases the melt index and gives the flexibility at the low temperature. It is well compatible with SBS, SEBS, SIS, PE. Major application of HMA is packaging, book-binding and disposable.

CAULK & SEALANTS

Caulks & Sealants are materials that are installed into a gap or joint to prevent water, wind, dirt or other contaminants through gap. Daelim Polybutene is used for caulks and sealant as tackifier and plasticizer with excellent non-drying UV stability and tackiness. The main use of caulks & sealants with Daelim Polybutene is for construction, automotive, ship-building and refrigerator.

GUM BASE

Daelim Polybutene passes the standards regulation designated by the Korea Food Additives Board, so it can be used as a base material for chewing and bubble gums.

<table>
<thead>
<tr>
<th>Item</th>
<th>PB1300F</th>
<th>PB1400F</th>
<th>PB1500F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity (cSt 100℃)</td>
<td>645</td>
<td>810</td>
<td>4700</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Verification Test</td>
<td>IR Spectrum</td>
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<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Bromine Reagent</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Heat Test</td>
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<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Solubility</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Chlorine Compound</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Alkali</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Heavy Metal</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Low Polymer Contents</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>High Heat Residue</td>
<td>Pass</td>
<td>Pass</td>
</tr>
</tbody>
</table>

WRAP FILM

The addition of Daelim Polybutene to LLDPE improves film properties including elongation, tear resistance, impact strength, tackiness and low temperature flexibility. Main application is industrial stretch film, wrap film as well as PB master batch for silage film.
LUBRICANTS

Two-Stroke Engine Oil
Two-Stroke (2T) engines are used in scooters, lawn mowers, chain saws and boats. Soot of 2T-engine at high temperature generates smoke in case of rapid acceleration and sudden stop. Daelim Polybutene easily depolymerizes at high temperature and leaves almost no carbon residue. Daelim Polybutene results in low carbon deposit formulation and emits low exhaust smoke (JASO FC grade) in the engine exhaust system.

Lubricant for Rolling and Wire Drawing
Traditionally, rolling and drawing oil have been based on mineral oil. Mineral oil must be removed from the metal before heating. However, Daelim Polybutene is not necessary to be cleaned or removed since it leaves almost no carbon residue. Unlike mineral oil, Daelim Polybutene does not cause problem in rolling operation and wire drawing involving aluminum and copper.

Compressor Oil
Daelim Polybutene is free of sulfur and other impurity, therefore it serves to remove the danger of catalytic poison and other problem.

Viscosity Index Improvers
As a viscosity index improver, Daelim Polybutene minimizes change in lubricant oil viscosity affected by temperature.

ELECTRICAL INSULATION
Daelim Polybutene has been applied to electrical applications because it does not contain inorganic material, sulfur and conductors. Daelim Polybutene shows excellent electrical properties.

Cable Jelly Compound
Because it has great heat stability, waterproof and low power factor, Daelim Polybutene is used for petroleum jelly compound.

Insulation Oil for Condenser
Daelim Polybutene has been applied to low voltage condenser as a insulation oil because of outstanding electrical properties, heat stability and oxidation stability.

OTHERS

Asphalt Modifier
Daelim Polybutene serves low temperature flexibility, waterproof, tackiness in the case of asphalt sheet.

Resin Plasticizer
Daelim Polybutene increases melt index and strength in the case of olefinic and styrenic resin.

Rubber Modifier
Daelim Polybutene improves tackiness, low temperature brittleness as a modifier.

Dispersing Agent
Daelim Polybutene can be used as a useful dispersing agent for the pigments, inks. Also, Daelim Polybutene is used as the assistant material of foaming agent of synthetic resin including PS, PE and PP.

SAFETY & PACKAGING TYPE

ISO14001
According to company’s strategy, Daelim has certification of ISO14001 and points to not only company development but also sustainable environmental development.

NSF (National Sanitation Foundation)
Aiming Industrial Safety & Health, Daelim registers Polybutene products on NSF which evaluates suitability of high quality and safety of products.

ROHS (Restriction of Hazardous Substances Directive)
Daelim Polybutene does not contain any substances from the list of RoHS.

SVHC (Substance of very high concern)
Daelim Polybutene is anti-toxic products, not sustaining the substances of SVHC.

SAFETY
Daelim Polybutene is safe to use, because it is non-toxic. Daelim Polybutene is allowed by the FDA for a wide variety of applications as components of articles. CAS Number : 9003-27-4

PACKAGING TYPE

<table>
<thead>
<tr>
<th>Drum (open/closed type)</th>
<th>IBC</th>
<th>Ios-container</th>
</tr>
</thead>
<tbody>
<tr>
<td>200L (198kg)</td>
<td>1kl (0.85MT)</td>
<td>24kl (20MT)</td>
</tr>
</tbody>
</table>
Daelim Polybutene is made by Daelim Industrial Co. Ltd., and distributed by Dealim Corporation.

For more information about Daelim Polybutene or product samples, please contact us.

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